# ANATOMICAL NOTES ON MALAY APES.

BY

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## I.—PRELIMINARY.

IN the autumn of 1889 my thoughts were directed towards the Pathology of Fever and Ague. Some years ago, research exposed in the blood an influx of a particular micro-organism during the attack. These microbes may be the actual fever-raising virus; or they may be the producers of the fever poison; or they may only be a concomitant of that poison. Be that as it may, the next important step in the evolution of our knowledge of the disease is to determine on what particular part of the body this poison immediately acts. Symptoms, remedies and alkaloids whose specific actions are known, point to a powerful affection of the great visceral sympathetic system of nerves. This system is probably the butt of the fever poison.

## II.—OBJECT OF RESEARCH.

(*a*)—It seemed well worth determining in a more exact manner than hitherto had been done, the anatomical relations of this nervous system, and I selected the quadrumana of this Siamese Province—Bangtaphan—lying at the eastern basis of the Peninsula.

(*b*)—And as about 80% of the natives, along the banks of the river of that Province, suffer to a greater or less degree from enlargement of the spleen, it was of interest to see if the quadrumana kept them company in this. But by confining my attention within so narrow limits, I should have committed great havoc among them for a small result.

(*c*)—So, after I had learned what might be called their normal structure, I looked for variations in their anatomy, and these variations—their amount and kind—signify a great deal.

(*d*)—In the young and almost adult members I observed the later acquired stages of development, to which DARWIN'S Law of Heredity can be applied.

(*e*)—And again, between the species of the same genus there are differences—the result of physiological processes. These are of great interest.

## III.—THE QUADRUMANA OF BANGTAPHAN.

A.—*Hylobates lar* (gibbon). (Wa-Wa).

Dissected 2 Adult Females.
1 Adult Male.
1 Fœtus.

I take the white circumfacial ring with the white dorsal aspects of the hands and feet as the distinctive mark of the species. In the three specimens the amount and distribution of the interdigital web varied ; so it does in all the species of monkeys I have examined ; the colour of hair is of little value, it varies with the sex, it varies with the year, and it varies with the animal's age.

B.—*Papio nemestrinus* (pig-tailed baboon).

Dissected 3 Adult Males.
3 Adult Females.
3 Juveniles.
1 Fœtus.

A stedfast species. It does not answer exactly to the description in MASON'S "Burmah," having the ringed hair, and also a remarkable leonine appearance—in the male only. The baby is of a greyish yellow colour with dark brown hairs along the spine. There is a remarkable resemblance to the young of the stumpy-tailed monkey.

C.—*Papio arctoides* (the stumpy-tailed baboon).

Not nearly so abundant as the last species. Of these, as yet I have made no dissections, but at present I have a couple of tame ones. One is quite a baby with a white face, hair of

a dirty yellow hue, and a black stripe down its back, which is spreading laterally.

D.—*Papio cynomolgus* (crab-eating baboon).

Abundant near the sea side. No dissections.

I have had tame specimens of all three species. Mentally they differ immensely. A young female *P. cynomolgus* was full of mischief, fun and fight. *P. nemestrinus* was quiet and retiring, but given to lasting fits of anger; while *P. arctoides* was a most staid individual with a far-away gaze and his whole mind seemed steadily occupied sexually.

E.—*Semnopithecus albocinereus* (Schinz), (steel-grey monkey).

Dissected 13 Adults.
2 Fœtuses.

F.—*Semnopithecus femoralis* (Horsfield), (black monkey).

Dissected 1 Adult.
1 Fœtus.

The fœtus and babies of both are of a dull buff yellow. *S. albocinereus* is anatomically very variable, as one would expect from the immense number of nearly allied species. In Bangtaphan both of these species are very abundant. They have very distinctive cries; that of *S. albocinereus* is a deep guttural ejaculation, while that of *S. femoralis*, though evidently produced in a similar manner, has a distinctive metallic timbre, which medical men would describe as a "cracked pot" sound.

G.—*Nycticebus tardigradus.* (Slow loris).

Rare. No dissections.

Elucidation of some of the details has required dissections of other animals, amongst these :—

1. A young Bornean mias (orang-utan).
2. Galeopithecus volans (2 specimens) (flying lemur).
3. Pteropus marginatus (2 specimens) (bat).

## IV.—Variation of the Spleen.

Within the bounds of health, the spleen varies in weight with the phase of digestion and period of the day. But I take it, that an increase of one-third in weight, beyond the average

relative weight of an organ, constitutes an abnormal condition of that organ. The accompanying table gives the actual and relative weight in most of the specimens I have examined, and chart I is a more lucid representation of the same. The spleen appears to be comparatively large in the mature fœtus, and enlargements are more common in adult females than adult males. In *Papio* and *Hylobates* the spleen seems to be wonderfully stedfast, while in the genus *Semnopithecus* the variability is great—from .0010 to .0055. But in none could I say there was a resemblance to the human ague spleen. The nearest approach to this condition I have yet come across was the spleen of a young female orang-utan. I have a young stumpy-tailed baboon who suffered at one time greatly from anæmia, his ears and face having the almost characteristic hue of malarious cachexia, but the fluctuations in his temperature were slight—102° to 102.75° F. Another very young stumpy-tailed monkey's temperature is 101.2° F., while the crab-eating monkey has a temperature of 101° F. Thus the results of the enlargement of the spleen, as an indication of fever in the monkeys, are negative.

## V.—Some of the Variations in Structure.

In the jungle, remote from reference, it is impossible to give an adequate account of these. I will broadly note the chief ones.

Of the three species I have examined, *Semnopithecus albocinereus* is the most variable; next *Hylobates lar;* while has *Papio nemestrinus* has a wonderfully stedfast structure. One would expect to find variation in those parts or organs:—

1st, which differ in nearly allied species and genera; or
2nd, which have undergone an increase or change of function.

The assumption of the semi-upright position by the lower quadrumana, and the downright position (using downright in distinction to upright as applied to man) by the higher quadrumana (*Hylobates* and *Simia*), has led to a change of function, in degree and kind, of many of the organs of the body. The rough diagrams *a, b, c* and *d* show partly what I mean. From these it can be seen that the line of support is continually changing. Thus the spinal column, especially about

the lumbar region, ought to show variations. This position further leads to a change in the mode of respiration, and we ought again to find variations in the bony structure of the chest, as in the sternum cartilages and ribs. And those parts are the most variable in the monkey organism.

(*a*)—*Variations* of the *Sternum*. (Breast-bone).

In the cartilaginous fœtal sternum, centres of ossification appear, and it is the almost universal condition in the mammalian kingdom, for the first centre to spread and form the first piece or manubrium, while the second, third, fourth and fifth may or may not unite to form the sternum. But in the genus *Hylobates* (gibbons) the rule seems to be for the first and second pieces to unite and form the manubrium. Of the four specimens I dissected, two united in this manner (diag. IV), nd two did not (diag. III). Professor DWIGHT called attention to this point (Journal of Anatomy, 1890) and gave the following cases, which I tabulate:—

| Specimens in which the 1st and 2nd pieces united to form manubrium. | Specimens in which the 1st and 2nd pieces did not unite. |
|---|---|
| Hylobates leuciscus, 2 specimens, (Dwight). | Hylobates lar, 1 specimen, (Dwight). |
| Hylobates varié, 2 Specimens, (Knox). | Hylobates lar, 2 specimens. |
| Hylobates syndactylus, 1 Specimen. | |
| Hylobates lar, 2 specimens. | |
| Total, 7 specimens. | Total, 3 specimens. |

Professor DWIGHT gives diag. I shewing the same condition in man, and diag. II shows it in *Hylobates leuciscus*. I found a very close approximation to the same form in a specimen of *Semnopithecus albocinereus* (see diag. VI). Professor DWIGHT is of the opinion that it means nothing more than that nature is on one of her accidental excursions, but the condition seems rather too wide spread for that. The sternum in the quadru-

mana is in a plastic condition, and the great development of the pectoral muscles—especially the manubrial portion of them—may determine the union of the first and second parts.

The sixth centre of sternal ossification appears late in juvenile life in the *Semnopitheci*, and in one adult it had failed to put in an appearance (see diag. VIII).

(*b*)—*Variations in Ribs and Chest Walls.*

In the same genus the eighth pair of ribs seem undecided whether they should terminate in the fibro-cartilage in front of the xiphoid or not come within an inch of it (see diags. VI, VII, VIII, IX, X). In *Papio nemestrinus* the eighth pair of ribs always reach the sternum (see diag. VIII). In a specimen of *Semnopithecus* the fifth rib terminated in a piece of cartilage to which some fibres of the diaphragm were attached (see diag. VI). In three specimens of the same genus, I came across rib-like developments in the fifth, sixth and seventh costal cartilages (see diag. VIII), and in all the adults, these cartilages were more or less ossified.

There are three floating ribs as a rule in *Semnopithecus*, but in two specimens the tenth rib had joined those above and become a false rib.

(*c*)—*Variations in the Lumbar Region.*

In a fœtus of *Papio nemestrinus*, I found the transverse process of the first lumbar vertebra enlarged and representing a thirteenth rib. It was costal in dimensions and appearance (see diag. XI). There was a similar condition in the second lumbar vertebra of *Hylobates lar*, representing a fourteenth rib (see diag. XII).

In the gibbon the twenty-sixth vertebra affects the chief support of the pelvic bones, while in the monkeys and baboons it is the twenty-seventh. Diag. XV shows the peculiar condition found in one of the *Semnopitheci*, on one side the twenty-seventh as usual is supported by the pelvic bones, but on the other side it is the twenty-eighth, the twenty seventh on that side having a plain transverse process. Professor G. B. HOWES (Journal of Anatomy, July, 1890) shows a similar condition in a frog (diag. XIV). The above-mentioned specimen shows considerable aggregations of cartilage on its twenty-fifth and twenty-sixth transverse process as if at one time they had

had intentions of having connection with the pelvic bones. Such growth of cartilage on the tips of transverse processes is not of uncommon occurrence (diag. XVI). In a fœtus of *Hylobates lar* the transverse process of the twenty-seventh vertebra was in a much further state of development than the twenty-sixth (diags. XVIII and XVII).

In one specimen of *Semnopithecus* the abdominal aorta divided on the twenty-fourth vertebra instead of the twenty-sixth, and smaller degrees of variation are common.

The arrangement of blood vessels in the pelvis is very variable. The insertion of the diaphragm may shift down a vertebra and the muscles arising from the anterior aspect of the lumbar region are also liable to variation.

(*d*)—*Variations in Muscles of the Limbs.*

With the great increase and change of functions in the arms of the *Hylobates,* one would not be surprised to come across variations in the muscles of these limbs. The biceps becomes the great muscle of locomotion, and in diag. XIX we have what might be called the normal condition—one head coming from the coracoid process, the other coming from the top of the glenoid cavity; while in diag. XX we have the glenoid head coming as usual, while the coracoid comes from the edge of the biceps groove. A curious thing, in connection with this, is the transference of the triceps head of the latissimus dorsi to the biceps, thus from an extensor in the monkeys and baboons, it becomes a flexor in the gibbons (*see* diag. XX).

There are also numerous variations amongst the extensor muscles of the forearm and leg, while there are numerous forms of arrangement in the arteries and veins of the lower limbs.

(*e*)—*Variations in the Viscera.*

Diag. XXI shows the appendix vermiformis of the gibbons—long, narrow and worm-like; that of the orang is almost similar; diag. XXII shows that of the pig-tailed baboon, only a contraction of the cæcum; diag. XXV gives the usual form of the cæcum of the *S. albocinereus*, with hardly an appendix at all, but sometimes it resembles that of the pig-tailed baboon as in diag. XXIV.

Sometimes in dissections of the human body we find the kidneys united by an isthmus of renal matter, such an arrangement being called the horse-shoe kidney. Diag. XXVI shows such a variation in *Semnopithecus*. In *Hylobates* (see diag. XXXVII) the thyroid gland has a large isthmus lying in front of the trachea; in *Papio* this isthmus is very attenuated; in *Semnopithecus* it is non-existent, although sometimes a rudimentary one may be met with. The thymus gland sometimes exists in adults, and sometimes is absent in infants.

This is but an introduction to the more superficial variations in the quadrumana. We can never know their correct systematic position, nor the direction of their evolutionary tendency, nor their relations to man and to their brother quadrumana, until these be known. And as the all-pervading tropical jungle is gradually being replaced by a vegetation necessary for the sustenance of increasing humanity, the quadrumana will be replaced by man. The century that will hold the apes in its conservatories of rarities, is not far distant, if coming centuries are at all like the great nineteenth.

## VI.—A few Points in Development.

(*a*)—*Ear.*

In each species of quadrumana the ear steadily maintains its characteristics. It attains its full growth long before maturity is reached, and still some of its transformations take place late in adult life. Diags. XXVIII and XXIX are from Darwin's well known illustrations showing the occurrence in the human helix of a slight protuberance probably likely representing the aural tip of the lower animals. In *Papio cynomolgus* this tip is large and remains unfolded (diag. XXX). In *Papio nemestrinus* and *Semnopithecus albocinereus* one can see this tip folding in late in fœtal life (diags. XXI and XXXII). In a specimen of *Hylobates lar* this tip was unfolded (diag. XXXII). The aural edge of the orang is folded to a greater extent than that of man and has no lobe, but on the other hand that of the *Semnopithecus* has the lobe and resembles closely the human ear. Man seems to have picked many of his parts in common with several of the quadrumana. The teeth of the *Semnopitheci* are more human than those of the orang.

(*b*)—*The Intertemporal Space and the Temporal Ridges.*
(See diags. XXXVI, XXXVII, XXXVIII, XXXIX).

The intertemporal space is bounded laterally by the temporal ridges from which rise the temporal muscles; in front by the frontal ridges, behind by the occipital ridges, from which rise the occipital muscles. In fœtal life and youth this space covers nearly the whole skull, but as the animal grows older the temporal muscles climb up the sides of the skull, while the occipital scramble up behind and the intertemporal space melts away before them. Thus the temporal ridges may crush it out and meet, as in the adult orang, and form a ridge. As a general rule, it may be taken that *the larger this space the greater the relative size of the brain to the body.* A small intertemporal space means large temporal and occipital muscles; large temporal muscles mean large canine teeth (fighting teeth) or coarse food; coarse food means a big stomach, and a big stomach, as I shall presently show, means a small brain. Keep away the effect of the big canine teeth and this intertemporal space can be formulated so as to give a wonderfully exact indication of the relative amount of brain matter.

But the proper signification of these temporal ridges has an important value in classification. They certainly cannot have any generic value, and little stress can be laid on them as specific distinctions, seeing the ease with which they could be varied and the degree in which they do vary with age and sex. They do not reach their final position until well into adult life.

(*c*)—*Epiphysis of the Bones.*

Take the scapula (shoulder blade) of the young monkeys for instance. Along the base we find a border of cartilage. This border foreshadows the further development the bone is to undergo (diags. XL, XLI, XLII.) According to DARWIN'S Law of Heredity, these borders represent the latest evolutionary acquisitions of the scapula. Thus XL, XLI, XLII represent the latest scapular additions made to *Semnopithecus*, *Papio*, and *Hylobates*. *Semnopithecus* and *Hylobates* have had their infra-spinatus space augmented, giving them increased arm

climbing power, while *Papio* has had both supra and infra-spinatus enlarged equally, which is probably connected with with their all-fours locomotion on the ground.

The lateral extension of the sternum seems to have a similar meaning. Indeed from the epiphysis we can read the late history of the animal.

Many of the tendinous insertions of muscles in adult life get assimilated with the periosteum of the underlying bones and thus there appears a difference in the adult and fœtal insertion of a muscle. (See diags. XLIII and XLIV).

## VII.—A few Physiological Considerations.

These problems are of even more interest than those of variation and development already given. But to understand their real meaning one must break through the conventional idea of human time. While the clock that marks the progress of things human has moved a century, the pendulum that registers the progress of the things of evolution has but swung a second. The failure to grasp a wider than vulgar view of time has kept many of the conservative naturalists from appreciating the final problems of evolution.

*How the Stomach, Brain and Muscles are correlated.*

The stomach of the three gibbons weighed, on an average, 903 grains, while on an average their contents (mostly green acid figs) weighed 4,100 grains. Their proportion to the weight of the body was respectively .0110 and .0462. Taking half-a-dozen of the *Semnopitheci*, their stomachs weigh 3,216 grains (relative weight=.0400) and contents 25,000 grains (.3200 of body weight). The table shows this more clearly.

| | Body Weight. | Stomach Weight. | Contents Weight. | Relative Weight, Stomach | Relative Weight, Contents |
|---|---|---|---|---|---|
| Hylobates lar, 3 Specimens, ... | 12.5 lbs. | 903 grs. | 4,100 grs. | .0110 | .0462 |
| Semno. albocinereus, 6 Specimens, | 15.4 lbs. | 3,216 grs. | 25,000 grs. | .0400 | .3200 |

That is, the gibbon carries a diet about one-twenty-fifth part of his weight and spends one-hundredth of his internal economy in carrying it and doing the first part of his digestion. On the other hand, this white-eyed, steel-grey monkey has to perform his locomotion with a diet load nearly one-third of his weight and expends as much as one-twenty-fifth part of his bodily substance on his stomach, as much as he does on his liver.

And it is from the stomach that the brain receives its impulse for work. And the progress is from a plentiful food supply that is difficult of digestion, such as the steel-grey monkey's staple and abundant diet amongst the bamboo leaves, to a scarcer and more inaccessible but more easily digestible food, as the green acid figs, and other fruit foods of the gibbon. On the one hand an intricate, large and expensive apparatus is used; on the other a simpler and smaller organ does the work. The extensive foraging excursions of the gibbon entail much more brain labour than the 'barn-door' feeding of the grey monkeys. The gibbon has added to his brain and subtracted from his stomach. And it was this simple mathematical calculation that brought us to where we are.

Such a statement the facts of the case bear out. We tabulate the brain statistics of the above group of monkeys, and this is how the matter stands:—

| | Average Bodily Weight. | Actual Brain Weight. | Relative Brain Weight. |
|---|---|---|---|
| Hylobates lar, ... | 12.5 lbs. | 1,607 grs. | .0187 |
| S. albocinereus, ... | 15.5 lbs. | 1,113 grs. | .0120 |

The relative weight of the brain is in inverse ratio to that of the stomach, the gibbons spending $\frac{1}{50}$ of their tissue on brain + $\frac{1}{100}$ on stomach, while the grey monkey spends about $\frac{1}{90}$ on his brain + $\frac{1}{25}$ on his stomach. Man has reached the furthest point in this direction; he spends about $\frac{1}{150}$ of his economy upon a stomach, he gives about $\frac{1}{50}$ to his brain. In a young rang-utan (7 months), I found the brain weighing one-four-

teenth of its bodily weight, while its stomach weighed a little over one-hundredth.

Chart II looks as if it did not bear out the statement that increase of brain means decrease of stomach. The orang is quite out of line, and in connection with this I would point out that the development of the brain seems not to be governed by the law that regulates the growth of other organs. The relative amount of brain matter is greatest in fœtal life; from that point onwards to full growth it diminishes. I tabulate the statistics derived from mother and child in the following species:—

| Species. | Weight of Adult Brain. | | Juvenile or Fœtal Brain. | |
|---|---|---|---|---|
| | Actual. | Relative. | Actual. | Relative. |
| Female Hylobates lar, | 1,620 grs. | .017 | 85 grs. | .12 |
| Semno. albocinereus, | 1,160 ,, | .016 | 460 ,, | .060 |
| Papio nemestrinus, ... | 1,340 ,, | .019 | 1,300 ,, | .216 |
| Bitch and Pup, ... | 1,180 ,, | .0056 | 595 ,, | .0218 |

Contrast this with the spinal cord development:—

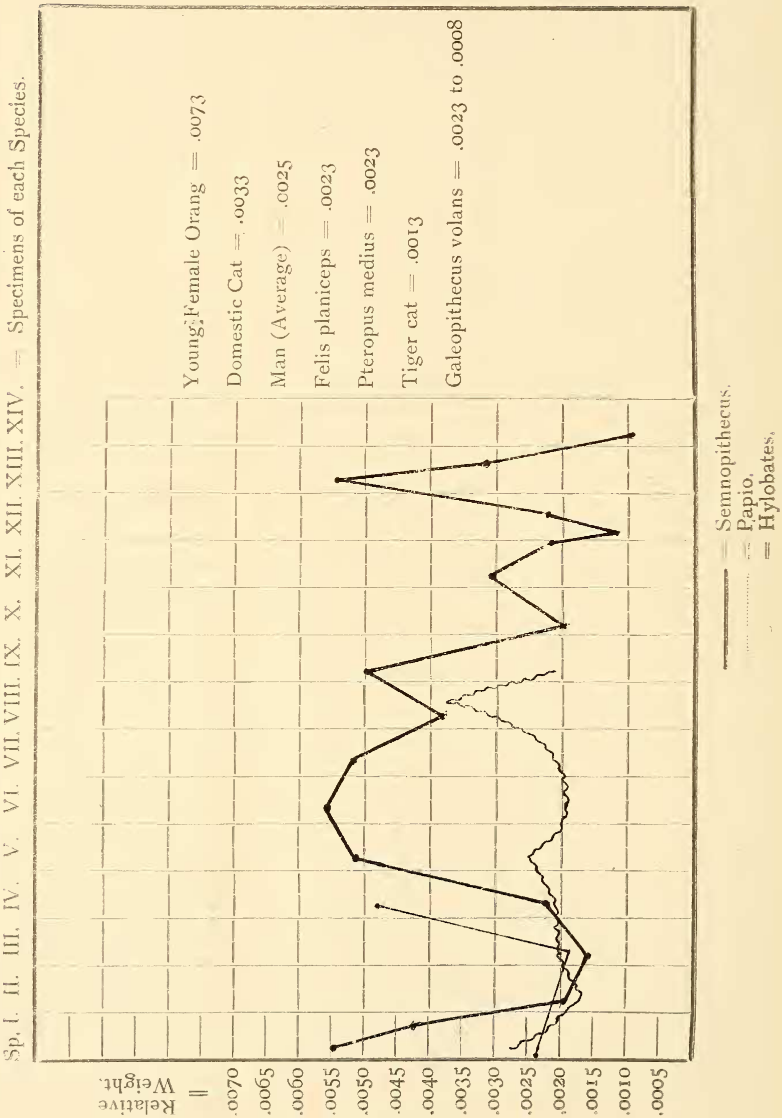
| Species. | Weight of Spinal Cord in Adult. | | Weight of Spinal Cord in Baby and Pup. | |
|---|---|---|---|---|
| | Actual. | Relative. | Actual. | Relative. |
| Papio nemestrinus, ... | 175 grs. | .0025 | 26 grs. | .0040 |
| Bitch and Pup, ... | 290 grs. | .0014 | 38 grs. | .00138 |

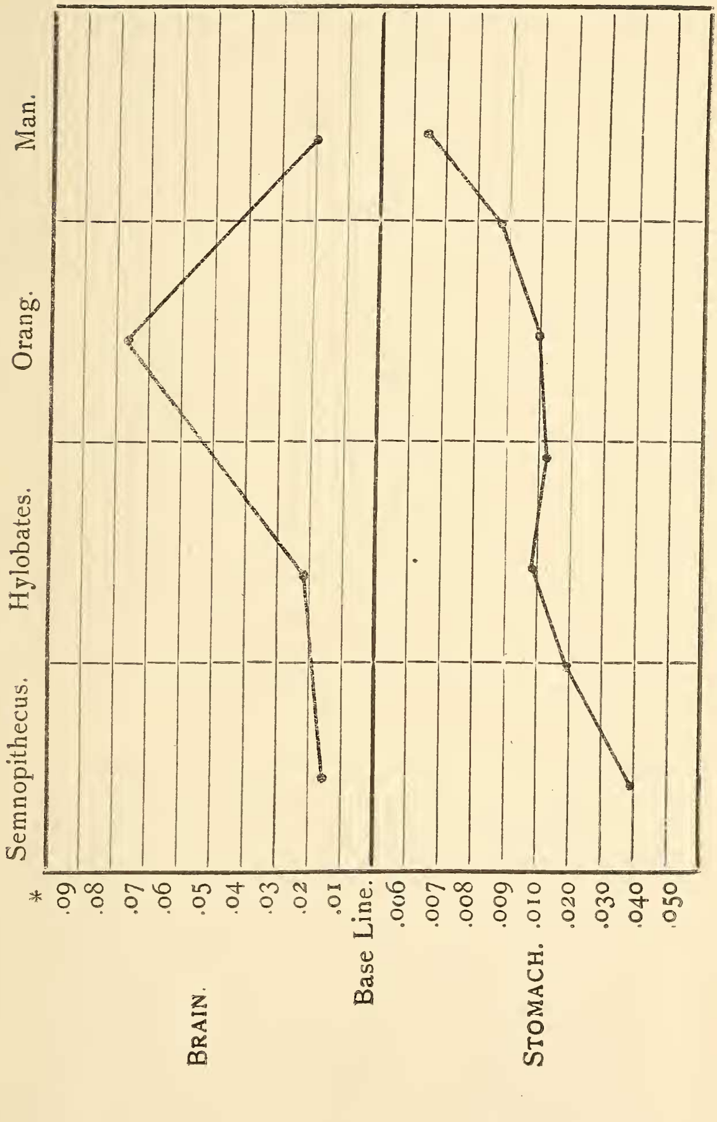
The other organs of the body increase much in ratio with the rest; it is so with the spinal cord, but the brain grows with no relation to the state of the other organs, save the stomach.

And the greater the cerebal development the greater is its disproportion to the other organs in fœtal life.

I should have liked to give some statements as to the correlation of brain and stomach, or what is the same thing, internal economy with external surroundings, by means of the muscular system, but as my paper has crept to considerable length, I will defer these and some other curious details which I have observed in the quadrumana of this region.

I.—Chart showing Degree of Variation of Weight of Spleen in Quadrumana.






II.—*Chart showing Correlation of Stomach and Brain.*

* Relative Weight of the Brain to Weight of the Body.